REMARKS

The present invention relates to a multi-layer gas sensor element and gas sensor comprising the same.

In the Office Action, claims 1, 3-5, 13, and 15-19 were rejected 35 U.S.C. § 102(b) as allegedly anticipated by Shibata et al (U.S. Patent 4,642,174).

Claims 1, 3-5, 9, 11, 13, and 15-19 were also rejected under § 102(b) based on Takahashi et al (U.S. Patent 4,595,485). Alternatively, the same claims were rejected based on Takahashi '485 as obvious under 35 U.S.C. § 103(a).

Claims 2, 6-8, and 14 were rejected under § 103(a) based on Shibata '174 in view of Mase et al (U.S. Patent 4,798,693). Claims 2, 6-8, 10, 12, and 14 were rejected under 35 U.S.C. § 103(a) based on Takahashi '485 in view of Mase '693.

Finally, claim 20 was rejected under 35 U.S.C. § 103(a) based on Shibata '174 in view of U.S. Patent 4,221,650 (Friese '650), or based on Takahashi '485 in view of Friese '650 furthermore with evidence from the Practical Handbook of Material Science.

In the present Amendment, Applicants have amended claim 1 to further specifically define the relationship that the thickness of each of the substrate and the porous member are at

least 1.5 times larger than that of a solid electrolytic member, and to further characterize the relationship of the mean grain size of the crystals constituting the substrate (a1) and those of the porous member (a2) such that the value $A=a1/a2$ falls within a range of from 0.9 to 5 inclusive.

Since the foregoing values are based on values that were set forth in claims 2 and 13, viz., in claims 13 and 2 respectively, claims 2 and 13 have been rendered redundant in view of amended claim 1, and are hence canceled herein.

It is clear in view thereof that the anticipation rejection based on Shibata '174 should be withdrawn. Similarly, the anticipation rejection based on Takahashi '485 should also be withdrawn.

Next, with respect to the § 103(a) rejections set forth at page 5 of the Office Action based on Shibata '174 in view of Mase '693, and the rejection of claims 2, 6-8, 10, 12, and 14 based on Takahashi '485 in view of Mase '693, these rejections should also be withdrawn, in view of the incorporation of claim 13 into claim 1, on which all of the foregoing noted claims depend, directly or indirectly. Applicants furthermore provide further comments regarding the deficiencies of the Shibata '174 reference and the Mase et al '693 reference below to facilitate the Examiner's understanding of the distinctness and patentability of the present invention.

Shibata et al (U.S. Patent 4,642,174) shows a porous insulating material 12 formed on the ceramic heater 11 by plasma flame spraying so that the porosity of the porous insulating material 12 can become as high as 20% (as shown in column 3, lines 31-41). An oxygen diffusion resistance layer 18 that has a porosity of 3 to 8% is formed on the surface of the outer periphery of the second electrode 17 by plasma flame spraying (as shown in column 4, lines 11-18).

Shibata et al teaches that the thermal expansion coefficient of the porous insulating material is within a range between those of the solid electrolyte film 14 and the ceramic heater sheet 111 (as shown in column 4, lines 19-40) so that a separation and detachment of the solid electrolyte layer from the adjacent film or layer is prevented.

Mase et al (U.S. Patent 4,798,693) shows two porous ceramic layers, 48 and 72, sandwiching the cell assembly so as to prevent the warpage of the sensing element (as shown in column 10, lines 55-59). However, in Mase '693 as shown in column 13, lines 25-28, the warpage could be of as little as 0.1 mm over the entire length of 30 mm.

In the present invention, the warpage is less than 2μm as shown in Tables 1 and 2. This is 1/50th or less than the lowest value that can be attained by Mase '693.

Therefore, the combination of Shibata '174 and Mase '693 can not lead to solving the problem of warpage to the level of less than 2μm, nor do these references show any suggestion as to how to solve the warpage problem as disclosed by the present invention.

Accordingly, the above discussed rejections under 35 U.S.C. § 103(a) should now be withdrawn.

The only other rejections relate to claim 20, which was rejected under § 103(a) based on Shibata '174 in view of Friese '650, or based on Takahashi '485 in view of Friese '650, further in view of the Practical Handbook of Material Science.

Of course, the disclosure of Shibata '174 has been discussed above. Friese et al '650 appears to be relied upon for the proposition that insulating materials such as alumina or magnesium-alumina spinel can be added to electrolyte to improve the thermal shock resistance, with the Practical Handbook of Material Science indicating that the volume of insulating material of Friese '650 is equivalent to the mass range claimed. Applicants respectfully submit that this rejection is insufficient, in that the Friese '650 is relied upon with respect to a single isolated feature. However, Friese et al does not supply the several missing features of the present invention *vis-à-vis* the Shibata '174 reference. Therefore, a *prima facie* case of obviousness is not established based on the mere supplementation of Shibata '174 with Friese '650. Accordingly, withdrawal of the

rejection based on Shibata '174 in view of Friese '650 further in view of the Practical Handbook of Material of Science is respectfully submitted to be proper.

With respect to the analogous rejection except for the substitution of Takahashi '485 for Shibata '174, the rejection is respectfully submitted to fail for the same reasons, viz., that Friese '650 is applied only to show a single feature missing from Takashi '485, and can not be considered as supplying all of the missing pieces by which one of ordinary skill in the art starting with Takahashi '485 would be lead to the presently claimed invention. Again, accordingly, the rejection of claim 20 based on Takahashi '485 in view of Friese '650 further in view of the Practical Handbook of Material Science should be withdrawn.

In view of this Amendment, remaining claims 1, 3-12, and 14-20 should be allowed forthwith.

Early favorable action is earnestly solicited.

In the event that the Examiner believes that it may facilitate the further prosecution of this application, the Examiner is invited to contact the undersigned attorney at the local Washington, D.C. telephone number indicated below.

AMENDMENT UNDER 37 C.F.R. § 1.111
U.S. Appln. No. 09/917,874

The USPTO is directed and authorized to charge all required fees, except for the Issue

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Respectfully submitted,

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APPENDIX
VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE CLAIMS:

Claims 2 and 13 are canceled.

The claims are amended as follows:

1. (amended) A multi-layer gas sensor element comprising a solid electrolytic member, a substrate, and a porous member, wherein each of the substrate and the porous member has a thickness of at least 1.5 times larger than that of the solid electrolytic member with respect to a lamination direction; the substrate and the porous member face each other and sandwich the solid electrolytic member; a ceramic component constituting the substrate in the highest volume percent thereof is the same as the ceramic component constituting the porous member in the highest volume percent thereof; and the volume percent (R2) of the ceramic component contained in the porous member is 80% or more of the volume percent (R1) of the ceramic component contained in the substrate,

wherein when the mean grain size of crystals constituting the substrate is referred to as "a1" and the mean grain size of crystals constituting the porous member is referred to as "a2," a value A represented by the following equation (1) falls within a range of from 0.9 to 5 inclusive:

$$A = a1/a2 \qquad (1).$$